Vibrations & Waves 19 & 20

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ movement back & forth; wiggle in time
2. Wave- a wiggle in \_\_\_\_\_\_\_\_\_\_\_\_\_\_ & \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
   1. Sound cannot travel in a \_\_\_\_\_\_\_\_\_\_\_\_\_\_. If there is no medium to vibrate, then \_\_\_\_\_\_\_\_\_\_\_sound is possible.
   2. Sound is the propagation of vibrations through a material medium—a \_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_, or \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
   3. Waves transmit \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and information.
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_ are both waves.
4. **Pendulums & Galileo;** The period does not depend on the amount of mass but does depend on the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Time required for a full oscillation (one round trip) is called the ***period*** of oscillation.
6. Pendulum that is about one meter long has a period of two seconds per oscillation.
7. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ - Frequency is the inverse of the period- or (Frequency) = 1/period. For example, for a period of 2 seconds per oscillation, the frequency is ½ oscillation per second or ½ Hertz. 1 Hertz = 1 oscillation per second
8. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ The distance from the rest position is the *amplitude* of oscillation.
9. A \_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a pictorial representation of a wave.
10. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ - the distance from the midpoint to the crest (or trough) of the wave. The amplitude equals the maximum displacement from equilibrium.
11. Like a water wave, a sine wave has \_\_\_\_\_\_\_\_\_\_\_\_\_\_, troughs and \_\_\_\_\_\_\_\_\_\_\_\_\_\_
12. Wave Description- The to-and-fro vibratory motion (often called oscillatory motion) of a swinging pendulum in a small arc is called simple \_\_\_\_\_\_\_\_\_\_\_\_\_\_ motion.
13. **Wave Motion**
    1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ - the stuff that carries the wave. Ex. water wave
    2. Barring obstacles the surface of the water will have been disturbed, but the water itself will have gone \_\_\_\_\_\_\_\_.
    3. A leaf on the surface will bob up and down as the waves pass, but will end up \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
    4. a stone dropped into a quiet pond has waves travel outward in expanding \_\_\_\_\_\_\_\_\_\_\_\_\_\_
14. Wave Motion
    1. When energy is transferred by a wave from a vibrating source to a distant receiver, there is *no* transfer of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ between the two points
    2. The energy transferred from a vibrating source to a receiver is carried by a *disturbance* in a \_\_\_\_\_\_\_\_\_\_\_\_\_\_, not by matter moving from one place to another within the medium
15. **Wave Speed...**the speed with which waves pass by a particular point, it depends only on the \_\_\_\_\_\_\_\_\_\_\_\_\_\_
16. Wave Speed = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ × \_\_\_\_\_\_\_\_\_\_\_\_\_\_
17. The source of all waves is something that \_\_\_\_\_\_\_\_\_\_\_\_\_\_. The frequency of the vibrating source and the frequency of the wave it produces are \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
18. A station at 101.7 MHz FM -a frequency of 101,700,000 hertz. Electrons in the transmitting antenna vibrate 940,000 times each second and produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_ -kHz radio waves.
19. **Transverse Waves-** For transverse waves the wave’s amplitude is \_\_\_\_\_\_\_\_\_\_\_\_\_\_ to the wave’s motion.
20. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ -is distance between crests or between troughs of waves.; a side to side vibration in a direction perpendicular to the wave's motion. Examples: water waves, waves on a rope
21. **Longitudinal Waves-** back and forth vibration in a direction \_\_\_\_\_\_\_\_\_\_\_\_\_\_ to the wave's motion; amplitude and wave motion are parallel.
22. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the waves provide information about the Earth’s interior. Waves generated by an earthquake. P waves are \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and travel through both molten and solid materials. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ are transverse and travel only through solid materials.
23. Wave Speed- The speed at which waves travel is called the wave speed. Speed of sound = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ m/s = 725 mi/hr. Speed of light = 300,000,000 m/s. The Wavelength of 20 Hertz is 16 m (about 50 ft.); Wavelength of 20,000 Hz is 1.6 cm (½ inch)
24. Hearing in Animals- bats, dolphins, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
25. Tsunami Waves- Tsunamis are ordinary water waves, typically generated by deep sea\_\_\_\_\_\_\_\_\_\_\_\_\_\_ they carry huge amounts of energy and momentum, traveling at almost 500 mph while in the Deep Ocean.
26. INTERFERENCE; Constructive or destructive interference results when waves \_\_\_\_\_\_\_\_\_\_\_\_\_\_
27. Standing Waves - wave pattern produced from \_\_\_\_\_\_\_\_\_\_\_\_\_\_ waves
28. Interference Pattern – within a pattern, wave effects may be \_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_, or \_\_\_\_\_\_\_\_\_\_\_\_\_\_
29. **Constructive Interference** (reinforcement) – the crest of one wave overlaps the crest of another, their individual effects add together producing an \_\_\_\_\_\_\_\_\_\_\_\_\_\_ amplitude
30. **Destructive Interference** (cancellation) – the crest of one wave overlaps the trough of another, their effects are \_\_\_\_\_\_\_\_\_
31. Waves with areas of zero amplitude are “\_\_\_\_\_\_\_\_\_\_\_\_” The high part of one wave simply fills in the low part of another.
32. When the crest of one wave overlaps the crest of another, they are “in phase”; their individual effects add together to produce a wave of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ amplitude.
33. Noise-canceling headphones use a microphone that listens for noise and a speaker that produces the same noise but out of phase (cancellation by \_\_\_\_\_\_\_\_\_\_\_\_\_\_ interference)
34. **Standing Waves-** There is no vibration at a node. There is maximum vibration at an \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
35. Standing Waves and Phase- Two sets of overlapping water waves produce an \_\_\_\_\_\_\_\_\_\_\_\_\_\_ pattern.
36. \_\_\_\_\_\_\_\_\_ **Effect**- Sound coming from a moving object has a different wavelength and frequency than if it were stationary.
37. If moving towards you, wavelength shorter and frequency \_\_\_\_\_\_\_\_\_\_\_\_\_\_. If moving away, wavelength is longer and frequency lower. the change in wavelength due to motion of the source ;; the apparent change in frequency due to the motion of the source (or receiver)
38. Blue Shift and Red Shift- When a light source approaches, there is an increase in its measured frequency called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_; and, when it recedes, there is a decrease in its frequency called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ spectrum
39. **Blue Shift –** an increase in frequency towards the high-frequency, or blue, end of the light spectrum (light source is moving \_\_\_\_\_\_\_\_\_\_\_\_\_\_ receiver)
40. **Red Shift -** a decrease in frequency towards the low-frequency, or red, end of the light spectrum (light source is moving away from the receiver) Distant galaxies show a red shift in the light they emit, indicating that the universe is expanding (or moving \_\_\_\_\_\_\_\_\_\_\_\_\_\_)
41. Bow Waves/Shock Waves- What actually happens is that the overlapping wave crests disrupt the flow of air over the wings, making it more difficult to control the craft. But the barrier is \_\_\_\_\_\_\_\_\_\_\_\_\_\_. In the early days of jet aircraft, it was believed that a pile-up of sound waves in front of the airplane imposed a “sound barrier” and that, in order to go faster than the speed of sound, the plane would have to “break the sound barrier.”
42. **Bow Wave –** when the speed of the source in a medium is \_\_\_\_\_\_\_\_\_\_\_\_\_\_, than the speed of the wave it produces it will catch up to the wave crests and pass them producing a V-shape. Overlapping at the edges occurs only when the bug swims \_\_\_\_\_\_\_\_\_\_\_\_\_\_ than wave speed. , increased speed of the source produces a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ V shape
43. **Shock Wave –** like a bow wave, but in three dimensions, produces a cone-shape
44. Supersonic?- \_\_\_\_\_\_\_\_\_\_\_\_\_\_ was the first person to break the sound barrier when he flew faster than the speed of sound in the X-1 rocket-powered aircraft on October 14, 1947.
45. **Sonic Boom –** produced when the conical shell of compressed air that sweeps behind a supersonic jet reaches listeners on the ground below. **-** Only when the craft moves faster than \_\_\_\_\_\_\_\_\_\_\_\_\_\_ do the waves overlap to reach the listener in a single burst. The sudden increase in pressure is much the same in effect as the sudden expansion of air produced by an explosion. Both processes direct a burst of high-pressure air to the listener.
46. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ - slower than the speed of sound; We don’t hear a sonic boom from slower-than-sound, or subsonic, aircraft because the sound waves reaching our ears are perceived as one continuous tone.
47. **The speed of sound in medium (*vs* = *v*, or** \_\_\_\_\_\_\_\_\_\_\_\_\_\_**). The speed of sound in air at sea level is about** \_\_\_\_\_\_\_\_\_\_\_\_\_\_  **m/s or about 750 mph**.   
    The wave fronts in front of the source are now all bunched up at the same point. As a result, an observer in front of the source will detect \_\_\_\_\_\_\_\_\_\_\_\_\_\_ until the source arrives. The pressure front will be quite intense (a shock wave), due to all the wave fronts adding together, and will not be perceived as a pitch but as a "thump" of sound as the pressure wall passes by.
48. Bow and Shock Waves- The fact is that a shock wave and its resulting **sonic boom** are swept \_\_\_\_\_\_\_\_\_\_\_\_\_\_ behind and below an aircraft traveling faster than sound, just as a bow wave is swept continuously behind a speedboat.
49. **Nature of Sound in Air**
    1. Sound requires a medium.- solid, liquid or gas
    2. Sound waves have compression and rarefaction regions.
50. **Origin of Sound**
    1. infrasonic frequencies < 20 Hz
    2. ultrasonic frequencies > 20,000 Hz
    3. human hearing range frequencies between \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Hz and \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Hz
51. **Speed of Sound in Air** 340 meters/second or 760 miles/hour; Mach 1
52. Lightning and Thunder; ***What is the approximate distance of a thunderstorm when you note a 3 second delay between the flash of the lightning and the sound of the thunder?*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
53. \_\_\_\_\_\_\_\_\_\_\_\_\_\_**...** ...the study of sound properties. When a sound wave strikes a surface it can be.… \_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_,
54. **Reflection of Sound-** e.g. an \_\_\_\_\_\_\_\_\_\_\_\_\_\_
55. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ n - re-echoed sound, multiple reflections of sound waves from walls
56. *Compare reflections from a hard wall with that from a carpet wall.*
57. **Refraction of Sound;** Refraction - the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of a wave
58. Sound travels faster in \_\_\_\_\_\_\_\_\_\_\_\_\_\_ air than in \_\_\_\_\_\_\_\_\_\_\_\_\_\_ air.
59. Sound waves bend toward \_\_\_\_\_\_\_\_\_\_\_\_\_\_ air.
60. **Forced Vibrations...**…the setting up of vibrations in an object by a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ force. Examples of Forced Vibration:
    1. A tuning fork touching a wood surface
    2. Sounding boards for stringed instruments
    3. Matching tuning fork boxes
61. **Natural Frequency...**…the frequency at which an elastic object \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_
    1. At this frequency, a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ energy is required to produce a forced vibration. The natural frequency of a body depends on its ... \_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_
62. **Resonance...**…is the result of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in a body when the applied frequency… ...matches the natural frequency of the body. The resulting vibration has high \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and can destroy the body that is vibrating.
63. In 1940, the Tacoma Narrows Bridge was destroyed by wind-generated resonance.
64. Imagine you’re sitting on a swing and want to go higher. You pump your legs at a certain rate to increase your swinging. This is an example of you creating \_\_\_\_\_\_\_\_\_\_\_\_\_\_ by matching the frequency of the swing.
65. **Sound Interference**
    1. Overlapping compressions of a sound wave will result in……\_\_\_\_\_\_\_\_\_\_\_\_\_\_ interference …and a louder sound.
    2. Overlapping a compression and a rarefaction results in... …\_\_\_\_\_\_\_\_\_\_\_\_\_\_ interference.…and a softer sound.
66. Beats - the periodic variation in \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of two sounds played together; The beat frequency is equal to the difference in the frequency of the two sounds. What is the beat frequency when a 262 Hz and a 266 Hz tuning fork are sounded together?
67. **Radio Broadcasts;** Modulation - an impression of the sound wave on a higher frequency radio wave. AM -Amplitude Modulation; 535 kHz to 1605 kHz; FM -Frequency Modulation; 88 MHz to 108 MHz
68. Constructive Interference occurs when waves are \_\_\_\_\_\_\_\_\_\_\_\_\_\_ phase; crests are superimposed and troughs are superimposed.
69. Destructive interference occurs when waves are \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of phase that is when crests are superimposed with troughs.

Vibrations & Waves 19 & 20

1. Vibration- movement back & forth; wiggle in time
2. Wave- a wiggle in space & time.
   1. Sound cannot travel in a vacuum. If there is no medium to vibrate, then no sound is possible.
   2. Sound is the propagation of vibrations through a material medium—a solid, liquid, or gas.
   3. Waves transmit energy and information.
3. Sound and Light are both waves.
4. **Pendulums & Galileo;** The period does not depend on the amount of mass but does depend on the length of the pendulum and acceleration of gravity
5. Period- Time required for a full oscillation (one round trip) is called the ***period*** of oscillation.
6. Pendulum that is about one meter long has a period of two seconds per oscillation.
7. Frequency- Frequency is the inverse of the period- or (Frequency) = 1/period. For example, for a period of 2 seconds per oscillation, the frequency is ½ oscillation per second or ½ Hertz. 1 Hertz = 1 oscillation per second
8. Amplitude- The distance from the rest position is the *amplitude* of oscillation.
9. A sine curve is a pictorial representation of a wave.
10. Amplitude- the distance from the midpoint to the crest (or trough) of the wave. The amplitude equals the maximum displacement from equilibrium.
11. Like a water wave, a sine wave has crests, troughs and amplitude
12. Wave Description- The to-and-fro vibratory motion (often called oscillatory motion) of a swinging pendulum in a small arc is called simple harmonic motion.
13. **Wave Motion**
    1. Medium - the stuff that carries the wave. Ex. water wave
    2. Barring obstacles the surface of the water will have been disturbed, but the water itself will have gone nowhere.
    3. A leaf on the surface will bob up and down as the waves pass, but will end up where it started.
    4. a stone dropped into a quiet pond has waves travel outward in expanding circles
14. Wave Motion
    1. When energy is transferred by a wave from a vibrating source to a distant receiver, there is *no* transfer of matter between the two points
    2. The energy transferred from a vibrating source to a receiver is carried by a *disturbance* in a medium, not by matter moving from one place to another within the medium
15. **Wave Speed...**the speed with which waves pass by a particular point, it depends only on the **medium**
16. Wave Speed = Frequency × Wavelength
17. The source of all waves is something that vibrates. The frequency of the vibrating source and the frequency of the wave it produces are the same.
18. A station at 101.7 MHz FM -a frequency of 101,700,000 hertz. Electrons in the transmitting antenna vibrate 940,000 times each second and produce 940-kHz radio waves.
19. **Transverse Waves-** For transverse waves the wave’s amplitude is perpendicular to the wave’s motion.
20. Wavelength-is distance between crests or between troughs of waves.
    1. side to side vibration in a direction perpendicular to the wave's motion. Examples: water waves, waves on a rope
21. **Longitudinal Waves-** back and forth vibration in a direction parallel to the wave's motion; amplitude and wave motion are parallel.
22. Reflections and refractions of the waves provide information about the Earth’s interior. Waves generated by an earthquake. P waves are longitudinal and travel through both molten and solid materials. S waves are transverse and travel only through solid materials.
23. Wave Speed- The speed at which waves travel is called the wave speed. Speed of sound = 330 m/s = 725 mi/hr. Speed of light = 300,000,000 m/s. The Wavelength of 20 Hertz is 16 m (about 50 ft.); Wavelength of 20,000 Hz is 1.6 cm (½ inch)
24. Hearing in Animals- bats, dolphins, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
25. Tsunami Waves- Tsunamis are ordinary water waves, typically generated by deep sea earthquakes they carry huge amounts of energy and momentum, traveling at almost 500 mph while in the Deep Ocean.
26. INTERFERENCE
27. Constructive or destructive interference results when waves add.
28. Standing Waves - wave pattern produced from interfering waves
29. Interference Pattern – within a pattern, wave effects may be increased, decreased, or neutralized
30. **Constructive Interference** (reinforcement) – the crest of one wave overlaps the crest of another, their individual effects add together producing an increased amplitude
31. **Destructive Interference** (cancellation) – the crest of one wave overlaps the trough of another, their effects are reduced
32. Waves with areas of zero amplitude are “out of phase” The high part of one wave simply fills in the low part of another.
33. When the crest of one wave overlaps the crest of another, they are “in phase”; their individual effects add together to produce a wave of increased amplitude.
34. Noise-canceling headphones use a microphone that listens for noise and a speaker that produces the same noise but out of phase (cancellation by destructive interference)
35. **Standing Waves-** There is no vibration at a node. There is maximum vibration at an antinode.
36. Standing Waves and Phase- Two sets of overlapping water waves produce an interference pattern. The left image is an idealized drawing of the expanding waves from the two sources. The right image is a photograph of an actual interference pattern.
37. **Doppler Effect**- Sound coming from a moving object has a different wavelength and frequency than if it were stationary. If moving towards you, wavelength shorter and frequency higher. If moving away, wavelength longer and frequency lower. the change in wavelength due to motion of the source ; the apparent change in frequency due to the motion of the source (or receiver)
38. Blue Shift and Red Shift- When a light source approaches, there is an increase in its measured frequency called a blue shift; and, when it recedes, there is a decrease in its frequency called a red shift spectrum
39. **Blue Shift –** an increase in frequency towards the high-frequency, or blue, end of the light spectrum (light source is moving towards receiver)
40. **Red Shift -** a decrease in frequency towards the low-frequency, or red, end of the light spectrum (light source is moving away from the receiver) Distant galaxies show a red shift in the light they emit, indicating that the universe is expanding (or moving further apart)
41. Bow Waves/Shock Waves- What actually happens is that the overlapping wave crests disrupt the flow of air over the wings, making it more difficult to control the craft. But the barrier is not real. In the early days of jet aircraft, it was believed that a pile-up of sound waves in front of the airplane imposed a “sound barrier” and that, in order to go faster than the speed of sound, the plane would have to “break the sound barrier.”
42. **Bow Wave –** when the speed of the source in a medium is as great, or greater, than the speed of the wave it produces it will catch up to the wave crests and pass them producing a V-shape. Overlapping at the edges occurs only when the bug swims faster than wave speed. , increased speed of the source produces a narrower V shape
43. **Shock Wave –** like a bow wave, but in three dimensions, produces a cone-shape
44. Supersonic?- [Chuck Yeager](http://www.senior-lifestyle.com/yeager.html) was the first person to break the sound barrier when he flew faster than the speed of sound in the X-1 rocket-powered aircraft on October 14, 1947.
45. **Sonic Boom –** produced when the conical shell of compressed air that sweeps behind a supersonic jet reaches listeners on the ground below. **-** Only when the craft moves faster than sound do the waves overlap to reach the listener in a single burst. The sudden increase in pressure is much the same in effect as the sudden expansion of air produced by an explosion. Both processes direct a burst of high-pressure air to the listener.
46. Subsonic- slower than the speed of sound; We don’t hear a sonic boom from slower-than-sound, or subsonic, aircraft because the sound waves reaching our ears are perceived as one continuous tone.
47. **The speed of sound in medium (*vs* = *v*, or Mach 1). The speed of sound in air at sea level is about 340 m/s or about 750 mph**.   
    The wave fronts in front of the source are now all bunched up at the same point. As a result, an observer in front of the source will detect nothing until the source arrives. The pressure front will be quite intense (a shock wave), due to all the wave fronts adding together, and will not be perceived as a pitch but as a "thump" of sound as the pressure wall passes by.   
    Bow and Shock Waves
48. The fact is that a shock wave and its resulting **sonic boom** are swept continuously behind and below an aircraft traveling faster than sound, just as a bow wave is swept continuously behind a speedboat.
49. **Nature of Sound in Air**
    1. Sound requires a medium.- solid, liquid or gas
    2. Sound waves have compression and rarefaction regions.
50. **Origin of Sound**
    1. infrasonic frequencies < 20 Hz
    2. ultrasonic frequencies > 20,000 Hz
    3. human hearing range frequencies between 20 Hz and 20,000 Hz
51. **Speed of Sound in Air** 340 meters/second or 760 miles/hour; Mach 1
52. Lightning and Thunder; ***What is the approximate distance of a thunderstorm when you note a 3 second delay between the flash of the lightning and the sound of the thunder? Answer*** *3 seconds* × *340 meters/second= 1020 meters*
53. **Acoustics...** ...the study of sound properties.
    1. When a sound wave strikes a surface it can be.…Reflected, Transmitted, Absorbed, All of these.
54. **Reflection of Sound-** e.g. an echo
55. Reverberation - re-echoed sound, multiple reflections of sound waves from walls
56. *Compare reflections from a hard wall with that from a carpet wall.*
57. **Refraction of Sound;** Refraction - the bending of a wave
58. Sound travels faster in warm air than in cool air.
59. Sound waves bend toward cooler air.
60. **Forced Vibrations...**…the setting up of vibrations in an object by a vibrating force. Examples of Forced Vibration:
    1. A tuning fork touching a wood surface
    2. Sounding boards for stringed instruments
    3. Matching tuning fork boxes
61. **Natural Frequency...**…the frequency at which an elastic object naturally tends to vibrate. At this frequency, a minimum energy is required to produce a forced vibration. The natural frequency of a body depends on its ...Elasticity, size, shape
62. **Resonance...** …is the result of forced vibrations in a body when the applied frequency… ...matches the natural frequency of the body. The resulting vibration has high amplitude and can destroy the body that is vibrating.
63. In 1940, the Tacoma Narrows Bridge was destroyed by wind-generated resonance.
64. Imagine you’re sitting on a swing and want to go higher. You pump your legs at a certain rate to increase your swinging. This is an example of you creating **resonance** by matching the frequency of the swing.
65. **Sound Interference**
    1. Overlapping compressions of a sound wave will result in……constructive interference …and a louder sound.
    2. Overlapping a compression and a rarefaction results in... …destructive interference.…and a softer sound.
66. Beats - the periodic variation in loudness of two sounds played together; The beat frequency is equal to the difference in the frequency of the two sounds. What is the beat frequency when a 262 Hz and a 266 Hz tuning fork are sounded together?
67. **Radio Broadcasts;** Modulation - an impression of the sound wave on a higher frequency radio wave. AM -Amplitude Modulation; 535 kHz to 1605 kHz; FM -Frequency Modulation; 88 MHz to 108 MHz
68. Constructive Interference occurs when waves are in phase; crests are superimposed and troughs are superimposed.
69. Destructive interference occurs when waves are out of phase that is when crests are superimposed with troughs.